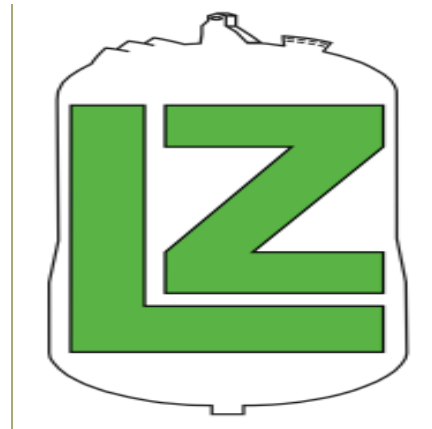# GammaX Study

Bhawna Gomber, Duncan Carlsmith, Sridhara Dasu [1]
Matthew Szydagis[2], Paolo Beltrame[3]

[1] University of Wisconsin
[2] Univerisity of Albany
[3] University of Edinburgh

+ Gamma-X Event

- GammaX Event : It is a multiple-scatter gamma event within the active region, with only one vertex in the drift region.

- Resulting signal has a composite S1 from all vertices, but S2 signal only from the drift region vertex.
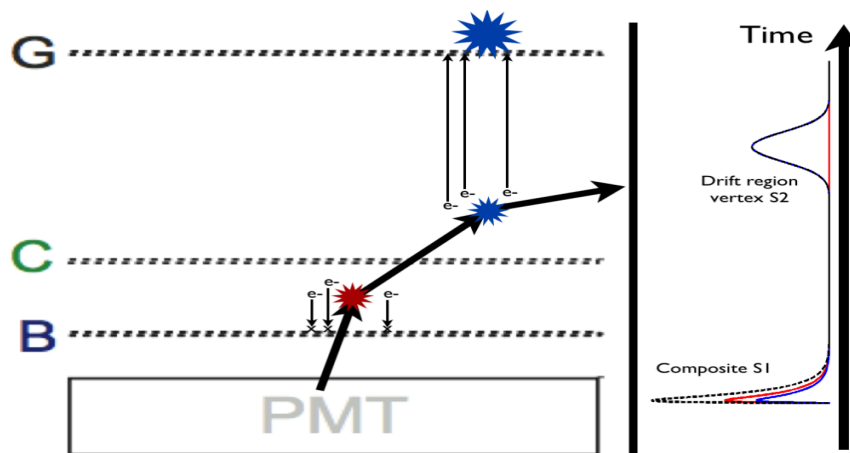

Figure 5.15: Qualitative representation of a gamma-X event. (Left) A γ scatters multiple times in the active region, with a single vertex in the drift region (small blue) and one or more vertices under the cathode (red). The resulting signal is shown at right as a function of time. The measured S1 signal is a composite signal from all vertices. Ionization is not collected from the vertices under the cathode. The resulting event has a single S2 which has a contribution only from the drift region vertex (large blue). (Right) The resulting waveform with detected S1 and S2 signals (black dashed). Shown are the contributions from the drift region vertex (blue) and RFR vertex (red). The reduced S2/S1 ratio for the event greatly lowers discrimination efficiency.

+ Gamma-X Simulation

- Simulation – Used the simulation files from Paolo
  - Set the radioactive source in the bottom array
  - Eg : /LUXSim/source/set Top_PMT_Vacuum DecayChain_Th232 1 mBq 100 yr
  - Simulation from four different radioactive isotopes U-238, Th-232, K-40, Co-60

- A Gamma-X event is considered to be an event in which
  - Energy deposition in the drift region is non-zero (Single-scatter) and
  - Energy deposition in the reverse field region OR under-cathode region is non-zero

Analysis Selection

- Select electron recoil events using the particle id to be of either an electron or photon.

- Single-scatter in the drift region, but can be multiple-scatter in the below-cathode region.
  - For single scatter events
    - Require the root mean square of the energy weighted distance between the single energy deposits and the centroid is less than spatial resoultion.
    - Position resolution in z and r is 0.2 and 3 cm respectively.

- Require energy between 1.5 and 6.5 KeV for electron recoils.

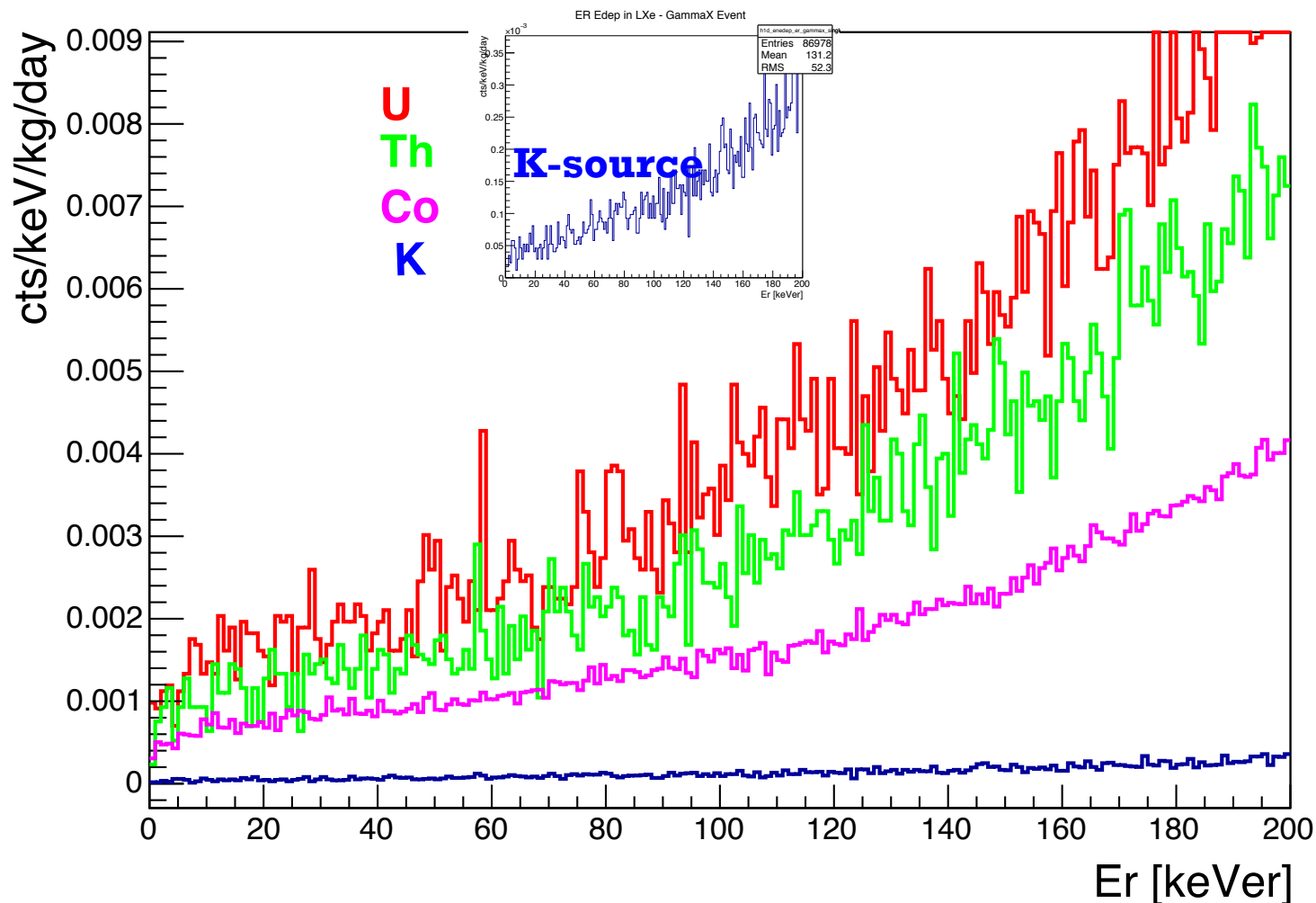- Count the number of events in the fiducial region.

+ Gamma-X Event

- Gamma-X event : Single scatter in drift region and multiple scatter in below cathode region

- Z position in below_cathode vs drift region

ER Edep pos. in LXe - Gammax (Single scatter drift region)
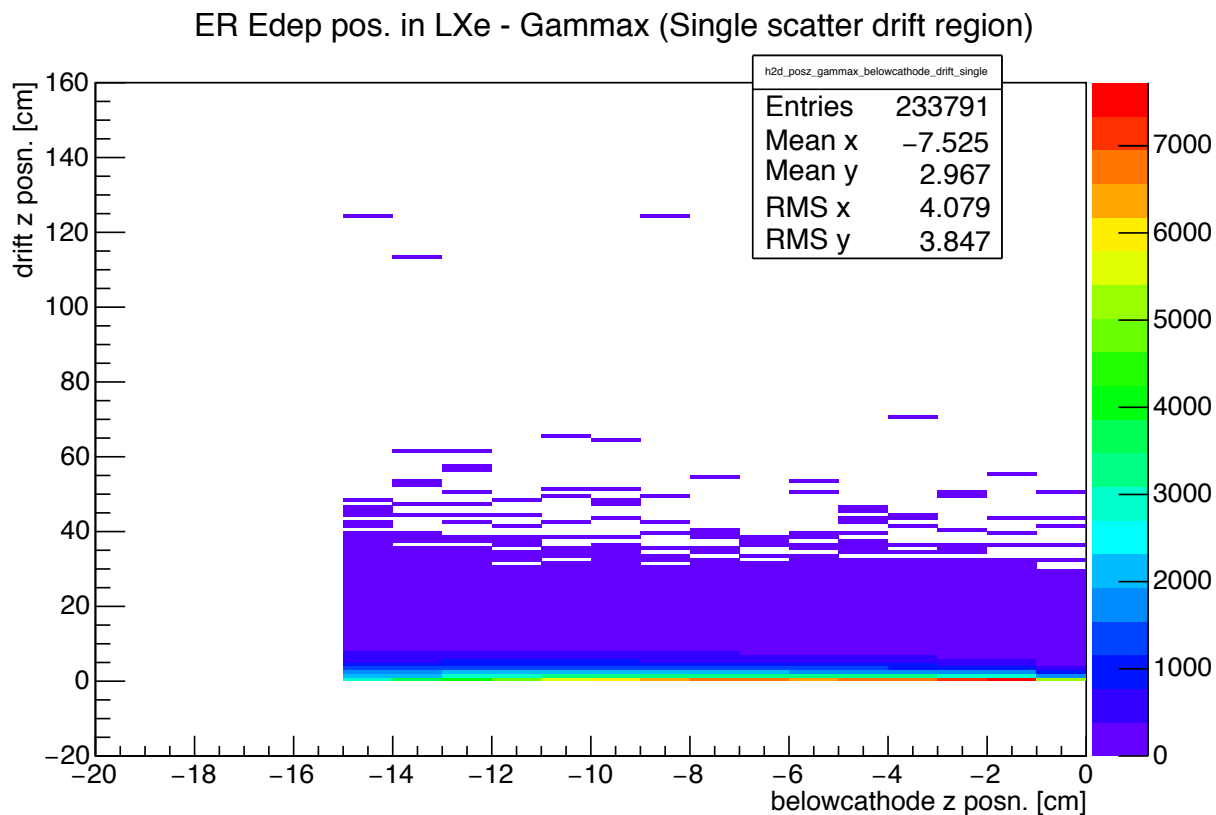
Gamma-X Event – Energy Deposited

ER Edep in LXe - GammaX Event

+ Event Count

- Fiducial Volume
    - R position is required to be less (radius_tpc -10 cm)
    - Z position is required to be within 5 cm and (height_tpc – 5cm)
    - Live days – U (586.1), Th(440), Co(2665.1), K(3601.9)

Events for livedays	U	Th	Co	K	Total
1) ER + Energy deposited between 1.5 and 6.5 KeV	1057.9	5231	1925	2372	?
2) 1+ Fiducial Volume	10.0	8.0	32.0	5.0	?
3) 2 + Gamma-X Events	0.0	0.0	4.0	0.0	?

- We see 4 events from Co source, that corresponds to 0.45 events for 300 live days.